# EX7000-OEM

## SCALABLE OPEN-ARCHITECTURE MICROWAVE INTERFACE

## USER'S MANUAL

**P/N: 82-0118-000**
**Release December 19, 2007**

**VXI Technology, Inc.**

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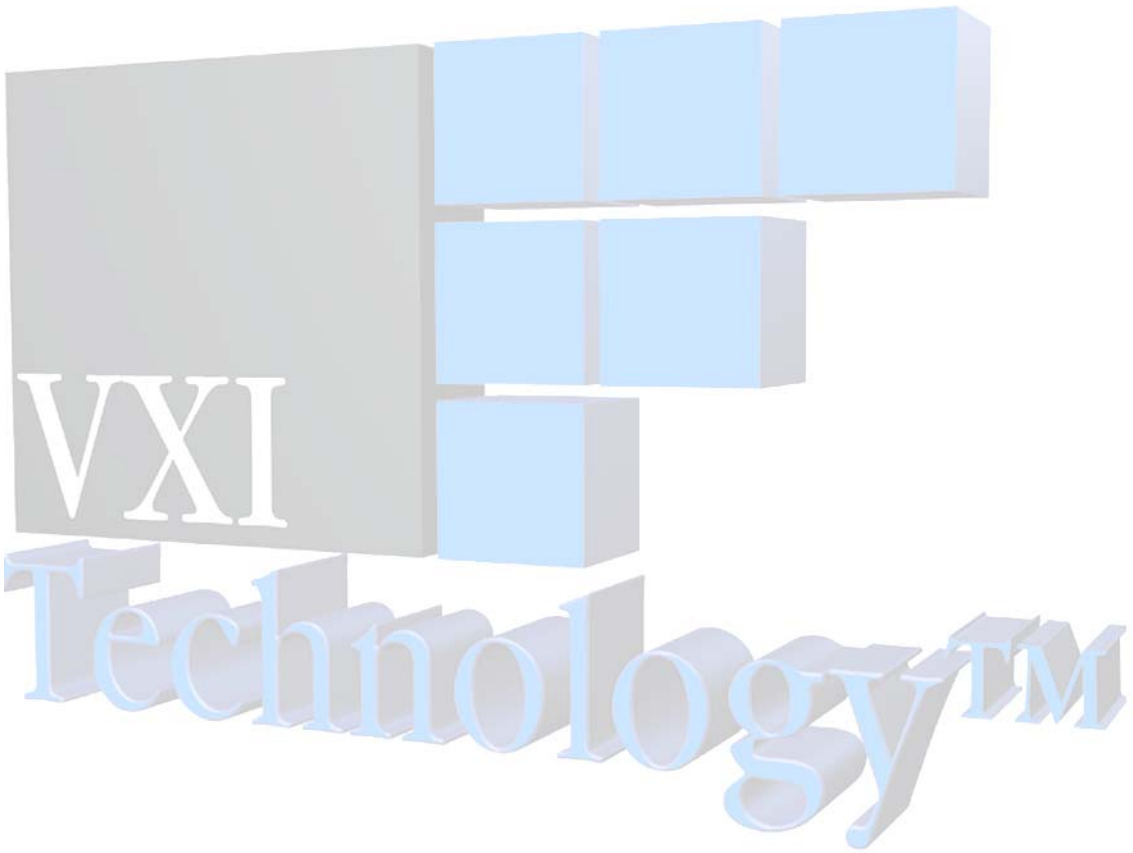
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## CERTIFICATION

VTI Microwave, a business unit of VXI Technology, Inc. (VTI) certifies that this product met its published specifications at the time of shipment from the factory. VTI Microwave further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

## WARRANTY

The product referred to herein is warranted against defects in material and workmanship for a period of one year from the receipt date of the product at customer's facility. The sole and exclusive remedy for breach of any warranty concerning these goods shall be repair or replacement of defective parts, or a refund of the purchase price, to be determined at the option of VTI Microwave.

For warranty service or repair, this product must be returned to a VXI Technology authorized service center. The product shall be shipped prepaid to VTI and VTI shall prepay all returns of the product to the buyer. However, the buyer shall pay all shipping charges, duties, and taxes for products returned to VTI from another country.

VTI Microwave warrants that its software and firmware designated by VTI Microwave for use with a product will execute its programming when properly installed on that product. VTI Microwave does not however warrant that the operation of the product, or software, or firmware will be uninterrupted or error free.

## LIMITATION OF WARRANTY

The warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, buyer-supplied products or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

VTI Microwave and VXI Technology, Inc. shall not be liable for injury to property other than the goods themselves. Other than the limited warranty stated above, VXI Technology, Inc. makes no other warranties, express or implied, with respect to the quality of product beyond the description of the goods on the face of the contract. VTI Microwave specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

## RESTRICTED RIGHTS LEGEND

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VTI Microwave
A VXI Technology, Inc. Business Unit
2031 Main Street
Irvine, CA 92614-6509 U.S.A.

# DECLARATION OF CONFORMITY

**Declaration of Conformity According to ISO/IEC Guide 22 and EN 45014**

| | |
|---|---|
| **MANUFACTURER'S NAME** | VXI Technology, Inc. |
| **MANUFACTURER'S ADDRESS** | 2031 Main Street<br>Irvine, California 92614-6509 |
| **PRODUCT NAME** | Scalable Open-Architecture Microwave Interface |
| **MODEL NUMBER(S)** | EX7000-OEM |
| **PRODUCT OPTIONS** | All |
| **PRODUCT CONFIGURATIONS** | All |

*VXI Technology, Inc. declares that the aforementioned product conforms to the requirements of the* Low Voltage Directive 73/23/EEC *and the* EMC Directive 89/366/EEC *(inclusive* 93/68/EEC*) and carries the "CE" mark accordingly. The product has been designed and manufactured according to the following specifications:*

CE Mark Pending

| | |
|---|---|
| **SAFETY** | EN61010 (2001) |
| **EMC** | EN61326 (1997 w/A1:98) Class A<br>CISPR 22 (1997) Class A<br>VCCI (April 2000) Class A<br>ICES-003 Class A (ANSI C63.4 1992)<br>AS/NZS 3548 (w/A1 & A2:97) Class A<br>FCC Part 15 Subpart B Class A<br>EN 61010-1:2001 |

*I hereby declare that the aforementioned product has been designed to be in compliance with the relevant sections of the specifications listed above as well as complying with all essential requirements of the Low Voltage Directive.*

**December 2007**

CE

***Steve Mauga, QA Manager***

# GENERAL SAFETY INSTRUCTIONS

Review the following safety precautions to avoid bodily injury and/or damage to the product. These precautions must be observed during all phases of operation or service of this product. Failure to comply with these precautions, or with specific warnings elsewhere in this manual, violates safety standards of design, manufacture, and intended use of the product.

***Service should only be performed by qualified personnel.***

## TERMS AND SYMBOLS

These terms may appear in this manual:

**WARNING** Indicates that a procedure or condition may cause bodily injury or death.

**CAUTION** Indicates that a procedure or condition could possibly cause damage to equipment or loss of data.

These symbols may appear on the product:

**ATTENTION -** Important safety instructions

Frame or chassis ground

Indicates that the product was manufactured after August 13, 2005. This mark is placed in accordance with *EN 50419, Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE).* End-of-life product can be returned to VTI by obtaining an RMA number. Fees for take-back and recycling will apply if not prohibited by national law.

## WARNINGS

Follow these precautions to avoid injury or damage to the product:

**Use Proper Power Source**

To avoid electrical overload, electric shock, or fire hazard, do not use a power source that applies other than the specified voltage.

**Operating Conditions**

To avoid injury, electric shock or fire hazard:

- Do not operate in wet or damp conditions.
- Do not operate in an explosive atmosphere.
- Operate or store only in specified temperature range.
- Provide proper clearance for product ventilation to prevent overheating.
- DO NOT operate if any damage to this product is suspected. ***Product should be inspected or serviced only by qualified personnel.***

**Improper Use**

The operator of this instrument is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.
Conformity is checked by inspection.

# SUPPORT RESOURCES

Support resources for this product are available on the Internet and at VXI Technology customer support centers.

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*Visit http://www.vxitech.com for worldwide support sites and service plan information.*

# SECTION 1

# INTRODUCTION

## INTRODUCTION

The EX7000-OEM family is the first scalable series of microwave subsystems built on an open-architecture Ethernet/LXI platform. It provides a common hardware platform and software communications interface that is designed to simplify the development of custom radio frequency interface unit (RFIU) requirements, while maintaining the look and feel of a standard product. The EX7000-OEM is designed for the end users who want to design and build their own RFIU, while minimizing development time of software and relay control.

The EX7000-OEM consists of an LXI Class A compliant digital controller interface and a 72-channel relay driver board. Optional driver expansion boards are available for designs that require additional drive control (up to eight per interface).

**FIGURE 1-1: EX7000-OEM-2 (SHOWN WITH OPTION PWD STACKING)**

## INTERACTIVE CONTROL

As an LXI-compliant device, the EX7000-OEM has an embedded web server running which provides a JAVA applet for interactively configuring the box for its specific configuration as well as allowing for the direct control of components. Configurations are stored on the EX7000-OEM's non-volatile memory to simplify the software development cycle.

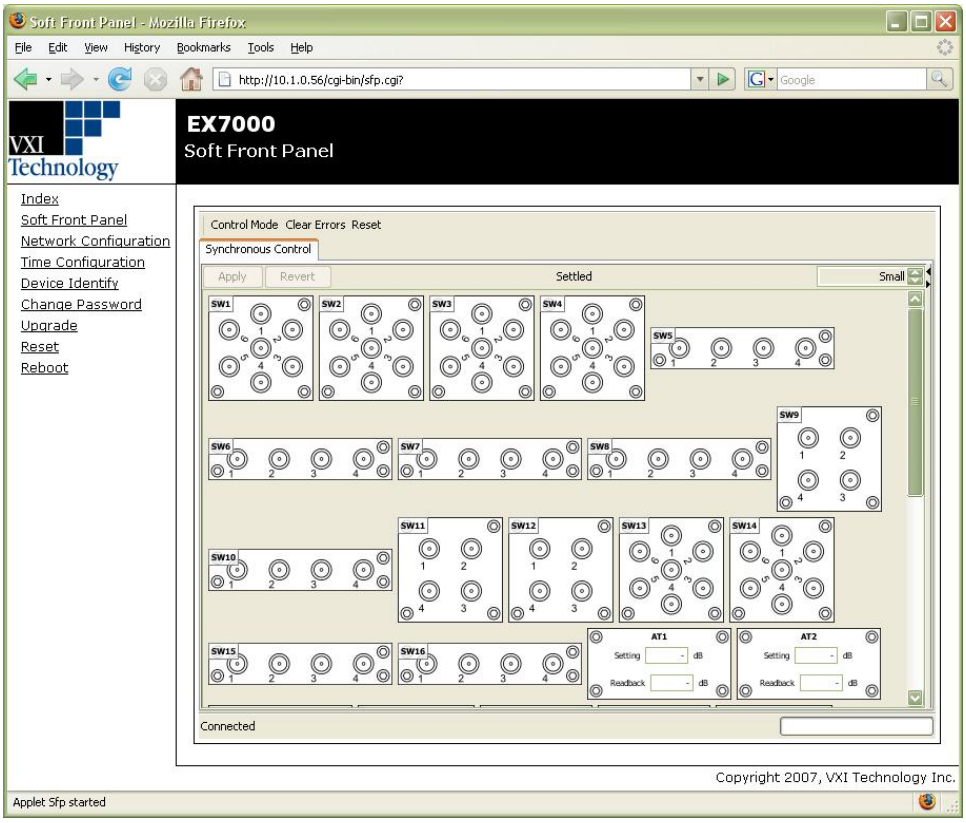



**FIGURE 1-2: JAVA-BASED GRAPHICAL USER INTERFACE**

## RELAY DRIVE CONTROL

The EX7000-OEM has been designed to provide maximum flexibility for controlling virtually any type of RF/microwave relay or component. The 72 high-current drivers are divided into twelve sections of six lines. Each section consists of:

- six high-current drive lines
- six indicator/status bits
- one reset line
- four relay ID bits
- one relay power input
- one 5 V input
- one ground

Each driver board is capable of recognizing and controlling either latching or non-latching relays. A programmable delay (per driver board) dictates the amount of time allocated to relay settling times and current cutoffs (for latching relays).

Each driver board has a single programmable delay parameter. The programmable delay for any board should be set to the maximum value required by any component connected to that board.

Data is latched to the gate of the FET dictating whether or not the FET will sink current and energize the relay coil. There is an optionally populated pull-up resistor from the FET drain to +5 V for connection to devices which require TTL control. This is detailed in the section below.

Each relay section can support identification of one relay if the relay has ID bits (optional on some types of relays) and the IDs are tied to the communications bus and the main interface board will report the data back to the application code. If indicator contacts are present, the status of the relay will also be reported back.

## INTERFACING WITH OTHER COMPONENTS

The EX7000-OEM is capable of controlling other programmable components, such as filters and attenuators, through either the high-current channels or the 32-bit parallel I/O. Consecutive channels can be grouped and allocated to a particular component and assigned a logical name which can be used in application code or through the graphical interactive utility.

Additionally, optional versions of the EX7000-OEM are available to convert the 72 drive lines such that they are capable of driving TTL inputs. Options are available for 24, 48, or 72 TTL capable drive lines. This is in addition to the 32-bit parallel I/O bus.

Channels are grouped and assigned to a logical name through the an intuitive graphical utility. As an example, eight consecutive channels on a driver board can provide the logic that controls an 8-bit attenuator. The command to set the attenuator is called as follows:

```
driver->Attenuator->Item[0].Data = 16;
<writes the value of 16 to the first attenuator in the list>
```

## FEATURES

### *Relay Odometer*

Each relay drive line has an associated “odometer” which tracks the number of times a relay coil has been actuated. This data is written to non-volatile memory and can be called from application code or the web interface. This assists preventative maintenance programs as relays can be closely monitored as they near end-of-life.

### *Exclude Lists*

The supplied API supports the implementation of exclude lists. Undesirable combinations of relay closures can be stored and warnings or errors will be generated any time an excluded combination is attempted. This helps prevent unsafe conditions such as shorting sources to ground or coupling one source to another.

### *Scan Lists*

Up to 16,000 scan list elements can be stored to help reduce overhead that can be accrued when relying on the host controller to manage the sequencing of switch states. A predefined list of switch states can be stored on-board and advanced through hardware control/handshaking with external system devices via the LXI Trigger Bus or the GP digital I/O port. Use of scan lists can considerably speed up test execution times.

### *Configuration Table*

The information included in the Configuration File allows the user to establish a complete signal route by indicating only the end points in an IVISwitch compliant Connect statement, thus simplifying the programming task.

### *Programmable MBB and BBM*

The application code can globally define whether or not the relays ‘break-before-make’ or ‘make-before-break’ when sequencing through relay setups.

# EX7000-OEM SPECIFICATIONS

| DIGITAL INTERFACE BOARD | |
|---|---|
| **PHYSICAL DIMENSIONS** | |
| | 15.2 cm (width) x 8.8 cm (depth) x 2.2 cm (height) |
| **CONNECTORS** | |
| **Host interface** | RJ-45 (CAT 5e) Ethernet (10/100T) |
| **Trigger bus** | Dual 25-pin mini D-Sub<br>8 LVDS in/out, LXI Class A |
| **GP Digital I/O** | 9-pin D-Sub<br>8 TTL I/O |
| **Power** | 4-pin power header, 5 V |
| **Reset** | Momentary push-button LAN reset |
| **Communication Bus** | 40-pin IDC (to relay driver board) |
| **PROCESSOR** | MCF5272 |
| **SDRAM** | 32 MB |
| **Flash ROM** | 8 MB |
| **Single-command Response Time** | < 3 ms |

| RELAY DRIVER BOARD | |
|---|---|
| **DIMENSIONS** | |
| | 18.4 cm (width) x 10.1 cm (depth) x 1.6 cm (height) |
| **MAXIMUM DISTANCE** | |
| **Interface Board to RDB** | 12 in – 16 in (first to last) |
| **CONNECTORS** | |
| **Communications bus** | 40-pin IDC |
| **Relay drivers** | 20-pin IDC |
| **Module ID** | Rotary switch |
| **Power** | 6-pin power header<br>(1) 5 V<br>(3) Ground<br>(2) EXT_SOURCE (5 V to 48 V) |
| **DIGITAL CONTROL LINES** | |
| | Dual 20-pin, 2 mm connectors |
| **INDICATOR** | |
| | Header for LXI compliant LEDs |
| **RELAY POWER** | |
| | +5 V to +48 V<br>*Three power pins, each connected to four relay driver connections |
| **RELAY DRIVERS** | |
| | 72 per board open-collector, expandable to 576 |
| **MAXIMUM CURRENT SINK** | |
| | 200 mA (all channels ON)<br>410 mA (individual channels) |
| **TTL I/O** | |
| | 32 channels per board, expandable to 256 |
| **MODULE ID** | |
| | Rotary switch (0 through 7 identifies driver board in chain) |

*Relay coil voltage is supplied to the relay driver board through three isolated power pins. Each pin is routed to a group of four driver connectors (6 drive lines per connector). The three coil voltage pins can be connected to the same supply voltage or to three different voltages. This provides the flexibility to use, for instance, 24 V, 12 V, and 5 V relays all with one driver board.

| SOFTWARE | |
|---|---|
| **PROGRAMMATIC CONTROL** | |
| | IVI-COM and IVI-C API<br>IVI similar API for Linux<br>DOS-based interactive command set<br>Low-level command set (EXP protocol) |
| **DIRECT CONTROL** | |
| | Embedded JAVA applet |
| **CONFIGURATION TABLE** | |
| | 128 elements (power-on, last known, user-defined) |
| **SCAN LIST** | |
| | 16k set-ups |

# SECTION 2

# PREPARATION FOR USE

## OVERVIEW

This section provides a step-by-step process for setting up the EX7000-OEM for use. It covers hardware installation, input connections, and software installation.

## UNPACKING

When the EX7000-OEM is unpacked from its shipping carton, the contents should include the following items:

- EX7000-OEM (plus options, if applicable)
- *EX7000-OEM User's Manual* (this manual)
- *VXI Technology, Inc. Drivers and Product Manuals* CD
- Digital Interface Cable (VTI P/N: 52-0497-003)

All components should be immediately inspected for damage upon receipt of the unit.

## INSTALLATION LOCATION

The EX7000-OEM is designed to be largely insensitive to external electrical, magnetic, and thermal disturbances. However, as with all precision instrumentation, certain precautions, if taken into consideration, can help achieve maximum performance.

1) The unit should be located away from sources of extreme high or low temperatures.
2) The unit should be located away from sources of high magnetic fields such as motors, generators, and power transformers.

The EX7000-OEM employs active cooling for maximum product reliability. When the EX7000-OEM is installed into a test fixture, the user must ensure that adequate air flow is provided to all components.

## DRIVER INSTALLATION

The EX7000-OEM is shipped with a *VXI Technology, Inc. Drivers and Product Manuals* CD which includes software drivers, user's manuals, the VXI Technology Product Catalog, as well as some third-party software. Please refer to the ReadMe.txt file included on the Distribution CD for installation instructions specific to revision of the CD provided.

## EX7000-OEM HARDWARE SETUP

To properly set up the EX7000-OEM for use, the following cabling connections must be made:

- The DCB must be connected to the RDB via the Digital Interface Cable provided with the EX7000-OEM. This cable should connect J1 on the DCB to either J1 or J1A on the RDB. The selection of RDB connector is made by positioning the jumper at J20. For more information on J1, J1A, and J20, please refer to the *Digital Interface Controller Connectors* section.
- A connection from the user-provided power supply must be made to J7 on the Digital Controller Board (DCB) and to J14 or J14A of the Relay Driver Board (RDB). If multiple RDBs exist, power must be supplied to each RDB. A cable can be made using the information provided in the *Power Connector* section, as well as information provided by the power supply manufacturer.
- A connection to the relays, attenuators, and filters must be made from the appropriate device to the RDB. Information in the *Relay Drive Connectors* section provide the user with the information needed to create an appropriate cable.
- A connection between the Host PC and the DCBs LAN port must be made. A CAT-5e cable may be used to make this connection. Note, this cable is not provided with the EX7000-OEM.

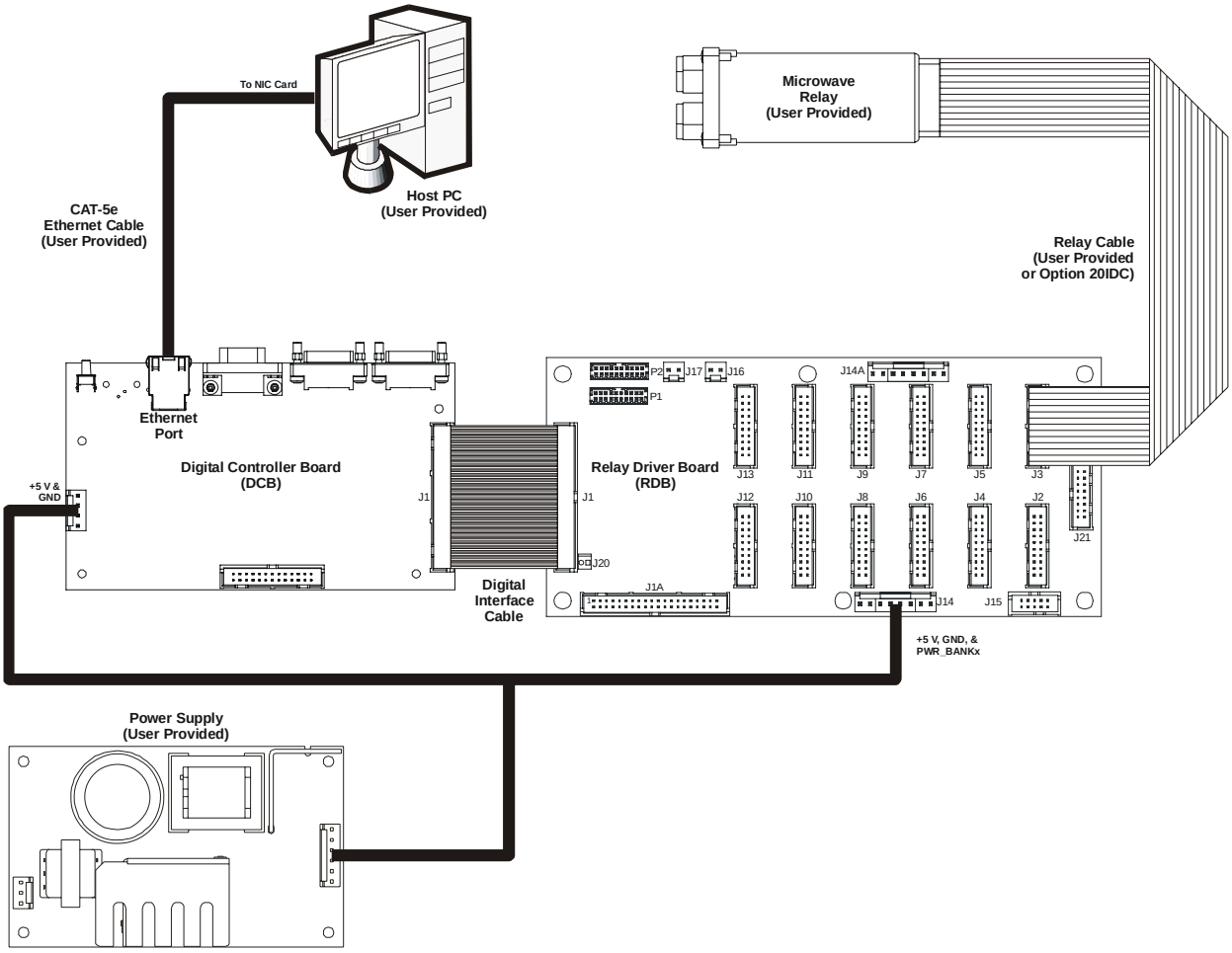



**FIGURE 2-1: EX7000-OEM CABLING DIAGRAM**

## OPEN-COLLECTOR VS. TTL DRIVE LINES

The RDBs of the EX7000-OEM may have varying quantities of open-collector and TTL drive lines, depending on the model ordered. This property is linked to the relay drive connector banks, as illustrated in Figure 3-3. The following table indicates how banks are used according the part number assigned.

| Part Number | Bank 0 | Bank 1 | Bank 2 |
|---|---|---|---|
| -000 | Open-collector | Open-collector | Open-collector |
| -001 | TTL | Open-collector | Open-collector |
| -002 | TTL | TTL | Open-collector |
| -003 | TTL | TTL | TTL |

**CAUTION**

**It is imperative that TTL banks only have TTL devices connected to them. Connecting an open-collector device to a TTL port will result in damage to the RDB and, potentially, to other equipment in the test system. Failure to comply with this warning will result in voiding the manufacturer's warranty.**

## NETWORK CONFIGURATION

With its default network configuration, the EX7000-OEM will attempt to locate a DHCP server. If one is found, the IP address assigned by the DHCP server will be used. Otherwise, after a timeout of 20 seconds, the unit will attempt to obtain an IP address by using AutoIP.

**NOTE** At any time, the EX7000-OEM can be returned to a known, default network configuration by using the LCI (LAN Configuration Initialize) mechanism. See *Reset Button* for more information.

AutoIP is a mechanism for finding an unused IP address in the range 169.254.X.Y, where X is in the range 1 through 254 and Y is in the range 0 through 255. The device will first attempt to obtain the specific address 169.254.X.Y, where X and Y are the second-to-last and last octets (bytes) of the device's MAC address. However, X will be set to 1 if it is 0 in the MAC address, and to 254 if it is 255 in the MAC address. This is in accordance with the AutoIP standard (RFC 3927). If this address is already in use, the unit will attempt to obtain other IP addresses in a pseudorandom fashion until it finds one that is available.

To illustrate the AutoIP mechanism, Table 2-1 lists the AutoIP default address for some example MAC addresses.

| MAC Address | AutoIP Default Address |
|---|---|
| 00:0D:3F:01:00:01 | 169.254.1.1 |
| 00:0D:3F:01:01:01 | 169.254.1.1 |
| 00:0D:3F:01:A3:28 | 169.254.163.40 |
| 00:0D:3F:01:FE:FE | 169.254.254.254 |
| 00:0D:3F:01:FF:FE | 169.254.254.254 |

**TABLE 2-1: AUTOIP DEFAULT ADDRESS ASSIGNMENT**

If a static IP address assignment is preferred, one can be optionally assigned via the embedded web page interface. This is done by clicking the **Network Configuration** link, disabling DHCP and AutoIP, enabling Static, and then assigning a static IP address, subnet mask, and gateway address, and, optionally up to three DNS servers. For more information, see *Network Configuration* in Section 4.

# SECTION 3

# HARDWARE DESCRIPTION

## OVERVIEW

An EX7000-OEM consists of the following, constituent parts:

- Digital Controller Board, or DCB
- Relay Driver Board, or RDB (may be one to eight boards depending on the model)
- A ribbon cable to connect the DCB to the RDB
- If multiple RDBs are used, a special ribbon cable with multiple connectors is required

The DCB provides the user interface to the host PC, via a LAN connection, and controls the action of the associated RDB cards. It is connected to the RDB cards via ribbon cables which run from its J1 connector to the J1 or J1A connector of the RDB. Also available on the DCB are the LXI trigger bus connectors, the Digital I/O connectors, and the LXI LAN Reset button.

The RDB is primarily responsible for providing control for the relays attached to the EX7000-OEM. The board contains connectors for relays, communication to the DCB, power supply inputs, optional LEDs, and parallel IOs. The remainder of this section will discuss, in detail, the constituent parts of the EX7000-OEM.

| **NOTE** | User must follow the specification listed below to make mating connectors. Deviation from these specification may result in incorrect operation, or damage to the system. |
|---|---|

## DIGITAL CONTROLLER BOARD DETAIL

Five connectors are located on the digital controller board (DCB) that are user accessible. Additionally, a reset button is provided for LCI functionality. The connectors provide access to the EX7000-OEM's DCB. The location of the connectors are provided below. Note, the power connector is not visible in the figure below.

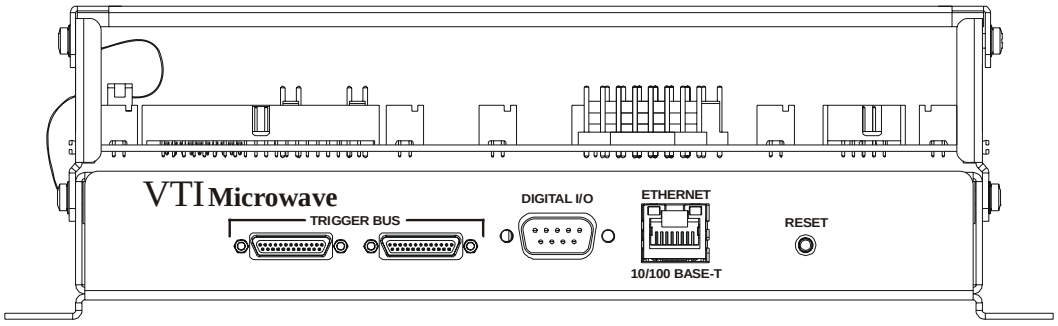


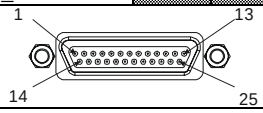

**FIGURE 3-1: EX7000-OEM REAR PANEL CONNECTORS (WITH OPTIONAL STACKING FRAME)**

Please note that Figure 3-1 depicts the EX7000-OEM mounted in an optional, single-high stacking frame. Additional sections can be added for up to eight relay driver boards stacked on top of the digital controller board.

### *Trigger Bus Connectors*

The EX7000-OEM provides an LXI compatible trigger bus connector. For more information on the LXI Trigger Bus and creating an appropriate cable, please visit *www.lxistandard.org* and refer to *LXI Standard Revision 1.1* and *LXI Trigger Bus Cable and Terminator Specifications Rev 1.1*.

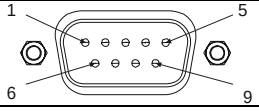
| Trigger Bus Connectors | | | |
|---|---|---|---|
| **Pin** | **Signal** | **Pin** | **Signal** |
| **1** | +3.3 V | **14** | RP_TRIG_P0 |
| **2** | GND | **15** | RP_TRIG_N0 |
| **3** | RP_TRIG_P1 | **16** | RESERVED |
| **4** | RP_TRIG_N1 | **17** | RP_TRIG_P2 |
| **5** | GND | **18** | RP_TRIG_N2 |
| **6** | RP_TRIG_P3 | **19** | GND |
| **7** | RP_TRIG_N3 | **20** | RP_TRIG_P4 |
| **8** | GND | **21** | RP_TRIG_N4 |
| **9** | RP_TRIG_P5 | **22** | GND |
| **10** | RP_TRIG_N5 | **23** | RP_TRIG_P6 |
| **11** | RESERVED | **24** | RP_TRIG_N6 |
| **12** | RP_TRIG_P7 | **25** | RESERVED |
| **13** | RP_TRIG_N7 | | |




### *Digital I/O Connector*

The EX7000-OEM features an 8-channel digital I/O port on the rear panel of the instrument. This port can be used as an arm/trigger source, for presentation of limit evaluation information, and as a general purpose output device. The digital I/O connector is a standard DB-9 with the following pin assignment:

| Digital IO Connector | | | |
|---|---|---|---|
| **Pin** | **Signal** | **Pin** | **Signal** |
| **1** | DIO Channel 0 | **2** | DIO Channel 1 |
| **3** | DIO Channel 2 | **4** | DIO Channel 3 |
| **5** | DIO Channel 4 | **6** | DIO Channel 5 |
| **7** | DIO Channel 6 | **8** | DIO Channel 7 |
| **9** | GND | | |




**Mating Connector**: Tyco 5-747904-2

As a general purpose output device, each DIO channel can be independently programmed with regards to its output functionality and its static level to assume when enabled as an output. When not enabled as an output, a channel becomes tri-stated, preventing conflict with other potential voltage drivers. Reference the port's electrical specifications in Table 3-1 for voltage tolerance limits and output drive capabilities. Regardless of output functionality, each channel provides constant input functionality. That is, the input level on each channel can be accessed without a specific enable command. Moreover, the base functionality of the DIO channels is not affected by triggering, scanning, or any other instrument process. Unless linked to a limit condition, as discussed below, its operation is completely autonomous.

When enabled as an output, each channel also has the ability to generate a 1 µs pulse upon command. An example application of this pulse is to use the EX7000-OEM to externally trigger another piece of test equipment. The specific operation of the pulse depends on the static level programmed for that channel. When a channel is programmed with a static level of high, the pulse will be low-going. When a channel is programmed with a static level of low, the pulse will be high-going. Each pulse generation requires a separate command.

For expanded and more automated operation, each DIO channel can be independently linked to one or multiple limit conditions on one or more input channels. This is termed a DIO Limit Event. For example, DIO channel 0 can be programmed to go high when the upper limit of set 0 for channel 2 or the lower limit of set 1 for channel 1 is exceeded. When linked as a limit event, a DIO channel will be cleared at the beginning of a new acquisition. Its state will then be updated with each scan according to the programmed limit evaluations. By default, the cleared state is low, but can be set on a per channel basis to be high through the use of the Invert setting. Similarly, the default operation of each channel is non-latch mode, but can be set on a per channel basis to be latch mode. In latch mode, a transition out of the cleared state would remain, regardless of future limit evaluations, until it is cleared at the beginning of a new acquisition.

It is important to note that the control of the DIO channels through DIO Limit Event assignment does not lock out control through the direct output mechanism. For example, even if a DIO channel has been set high by a DIO Limit Event, it could be asynchronously set low through direct output control. Because limits can only be evaluated as fast as data is being acquired, there could be an application that employs a slow sampling rate but requires the DIO channel to be reset sooner than the normal limit evaluation mechanism would do it. The direct DIO control provides this capability. Use of that control does not alter or disable the limit event mechanism controls; it simply asynchronously alters the level of the DIO channel output. Upon the next scan (and subsequent limit evaluation), the DIO channel will be updated normally per its DIO Limit Event configuration. In general, however, an application will employ only one control mechanism. For that reason, if a DIO channel is linked as a DIO Limit Event, this is noted in the direct control mechanism as a pseudo-warning to guard against accidental use.

The default selections for each DIO channel are:

- output enable is off
- output level is 0

The default selections for DIO Limit Events are:

- all channels are disabled
- invert is off
- latch is off

The electrical specifications for the digital I/O port are provided in Table 3-1. Particular note should be given to the $V_{INPUT}$ specification of -0.5 V to 5.5 V. Exceeding that value with an external voltage source, even through a resistance, could permanently damage the EX7000-OEM.

| Characteristic | Value |
|---|---|
| $V_{INPUT}$ | -0.5 V to 5.5 V |
| $V_{IH}$ | 2 V min |
| $V_{IL}$ | 0.8 V max |
| $V_{OH}$ ($I_{OH}$ = -32 mA) | 2 V min |
| $V_{OL}$ ($I_{OL}$ = 64 mA) | 0.55 V max |

**TABLE 3-1: DIGITAL I/O PORT ELECTRICAL SPECIFICATIONS**

### *Reset Button*

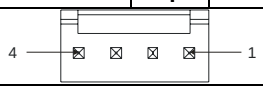
The reset button on the rear panel of the EX7000-OEM, implemented according to the LXI LAN Configuration Initialize (LCI) Mechanism specification, can be used to restore default network settings. This is useful for recovery from an incorrect or unknown network configuration. To perform a network reset:

1) Press and hold the reset button.
2) Continue to hold the reset until the LAN LED flashes (approximately 5 s).
3) Release the reset button.

The EX7000-OEM will now revert back to the default network configuration (DHCP and AutoIP enabled) instead of its previous settings. VXI-11 Discovery (supported by the VISA IO-Libraries) can be used to determine the IP address of the instrument.

### *Power Connector*

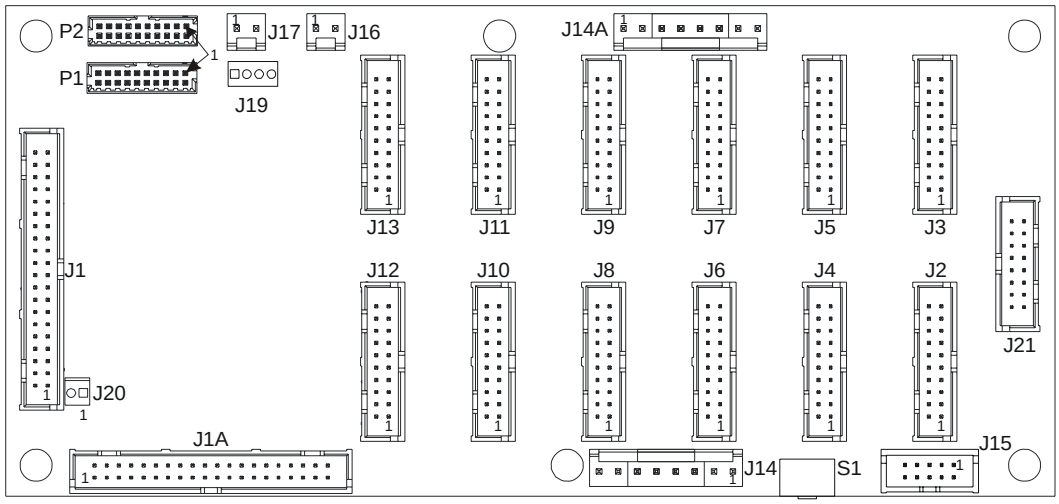
The connector located at J7 is used to supply dc power to the DCB.

| Power Connectors | | | |
|---|---|---|---|
| **Pin** | **Signal** | **Pin** | **Signal** |
| **1** | GND | **2** | +5 V |
| **3** | +5 V | **4** | GND |
|  | | | |
| **Mating Connector**: AMP 640250-4<br>**Crimp Pins**: AMP 640706-1 | | | |



## RELAY DRIVER BOARD DETAIL

The relay diver board (RDB) has several connector interfaces which are made available to the user. A description of the connectors and their function follows.




NOTE: J19 and J21 are reserved for future use.

**FIGURE 3-2: EX7000-OEM RDB CONNECTOR LOCATIONS**

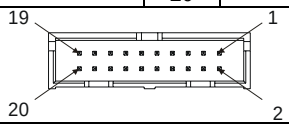
### *Digital Interface Controller Connectors*

The J1 and J1A connectors are used to connect the relay driver board to the controller board. J1 and J1A are interchangeable for ease of usage. When J20 is jumpered, J1A will be utilized, otherwise, J1 is used.

### *Relay Drive Connectors*

Connectors J2 through J13 are Relay Drive connectors. On each connector, there will be:

1) 6 relay drive outputs capable of 200 mA (410 mA for three or fewer channels)
2) 6 relay indicator inputs which will provide the relay coil status, if applicable
3) 4 relay ID inputs
4) 1 relay reset output, capable of sinking up to 800 mA to reset all relay coils

| Relay Drive Connectors | | | | |
|---|---|---|---|---|
| **Designator** | **Pin** | **Signal** | **Pin** | **Signal** |
| **J2 through J13** | **1** | PWR_BANKx | **2** | RELAY_DRIVE0 |
| | **3** | RELAY_DRIVE1 | **4** | RELAY_DRIVE2 |
| | **5** | RELAY_DRIVE3 | **6** | RELAY_DRIVE4 |
| | **7** | RELAY_DRIVE5 | **8** | RELAY_INDICATOR0 |
| | **9** | RELAY_INDICATOR1 | **10** | RELAY_INDICATOR2 |
| | **11** | RELAY_INDICATOR3 | **12** | RELAY_INDICATOR4 |
| | **13** | RELAY_INDICATOR5 | **14** | RELAY_ID0 |
| | **15** | RELAY_ID1 | **16** | RELAY_ID2 |
| | **17** | RELAY_ID3 | **18** | RELAY_RST_DRV |
| | **19** | GND | **20** | +5V |
| **Connector Pin Locations** |   | | | |
| **Mating Connector** | 3M P/N: 3421-7600 (or similar) | | | |

**CAUTION**

**It is imperative that TTL banks only have TTL devices connected to them. Connecting an open-collector device to a TTL port will result in damage to the RDB and, potentially, to other equipment in the test system. Failure to comply with this warning will result in voiding the manufacturer's warranty.**

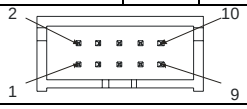
### *Power Connectors*

Either J14 or J14A can be used to supply dc power to the relay driver board. PWR_BANKx voltage can range from 5 V to 45 V.

| Power Connectors | | | | |
|---|---|---|---|---|
| **Designator** | **Pin** | **Signal** | **Pin** | **Signal** |
| **J14 & J14A** | **1** | PWR_BANK0 | **2** | GND |
| | **3** | PWR_BANK1 | **4** | GND |
| | **5** | PWR_BANK2 | **6** | GND |
| | **7** | +5 V | **8** | +5 V |
| **Connector Pin Locations** | | | | |
| **Mating Connector** | AMP P/N: 640250-8 (connector)<br>AMP P/N: 640706-1 (crimp pins) | | | |

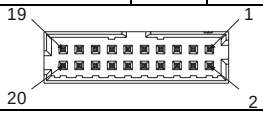
### *LED Connectors*

A header is provided here for compliance with the LXI Standard. For more information, please visit *www.lxistandard.org* and refer to *LXI Standard Revision 1.1* for LED function.

| LED Connectors | | | | |
|---|---|---|---|---|
| **Designator** | **Pin** | **Signal** | **Pin** | **Signal** |
| **J15** | **1** | GND | **2** | PWR_GRN |
| | **3** | PWR_RED | **4** | LAN_GRN |
| | **5** | LAN_RED | **6** | 1588_GRN |
| | **7** | 1588_RED | **8** | Reserved |
| | **9** | N/C | **10** | GND |
| **Connector Pin Locations** |  | | | |
| **Mating Connector** | AMP P/N: 746288-1 | | | |

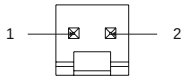
### *Parallel TTL IO Ports*

The PIO port signals are bi-directional, +5 V TTL input/output ports. They can write to and be written from an external device.

| Parallel TTL IO Ports | | | | |
|---|---|---|---|---|
| **Designator** | **Pin** | **Signal** | **Pin** | **Signal** |
| **P1** | **1** | GND | **2** | GND |
| | **3** | PIO_PORT0 | **4** | PIO_PORT1 |
| | **5** | PIO_PORT2 | **6** | PIO_PORT3 |
| | **7** | PIO_PORT4 | **8** | PIO_PORT5 |
| | **9** | PIO_PORT6 | **10** | PIO_PORT7 |
| | **11** | PIO_PORT8 | **12** | PIO_PORT9 |
| | **13** | PIO_PORT10 | **14** | PIO_PORT11 |
| | **15** | PIO_PORT12 | **16** | PIO_PORT13 |
| | **17** | PIO_PORT14 | **18** | PIO_PORT15 |
| | **19** | +5V | **20** | +5V |
| **P2** | **1** | GND | **2** | GND |
| | **3** | PIO_PORT16 | **4** | PIO_PORT17 |
| | **5** | PIO_PORT18 | **6** | PIO_PORT19 |
| | **7** | PIO_PORT20 | **8** | PIO_PORT21 |
| | **9** | PIO_PORT22 | **10** | PIO_PORT23 |
| | **11** | PIO_PORT24 | **12** | PIO_PORT25 |
| | **13** | PIO_PORT26 | **14** | PIO_PORT27 |
| | **15** | PIO_PORT28 | **16** | PIO_PORT29 |
| | **17** | PIO_PORT30 | **18** | PIO_PORT31 |
| | **19** | +5V | **20** | +5V |
| **Connector Pin Locations** |  | | | |
| **Mating Connector** | Molex P/N: 87568-2043 | | | |

### *Fan Power Connectors*

J16 and J17 provide the power to the fan. Note, the voltage at J16/J17 come from PWR_BANK2.

| Fan Power Connectors | | | | |
|---|---|---|---|---|
| **Designator** | **Pin** | **Signal** | **Pin** | **Signal** |
| **J16 & J17** | **1** | PWR_BANK2 | **2** | GND |
| **Connector Pin Locations** |   | | | |
| **Mating Connector** | Tyco P/N: 3-640441-2 | | | |

### *Address Switch*

The rotary switch located at S1 sets an RDB's address. The 16 position is only valid in the 0 through 7 range. Setting an RDB to addresses 8 through F is not defined and should not be used.

**NOTES** In EX7000-OEM systems that include multiple RDBs, it is imperative that each RDB be set to a unique address. The address does not have to be in sequential order.

### *Relay Banks*

The EX7000-OEMs relay drive connectors on the RDB are partitioned into three banks: J2 through J5 constitute bank 0, J6 through J10 bank 1, and J11 through J14 bank 2. Although a single RDB may contain both latching and non-latching devices, the banks may only contain one type of device. For example, if J2, J3, and J4 are connected to non-latching devices, J5 may only contain a non-latching relay. A latching relay could, however, be installed in J6.

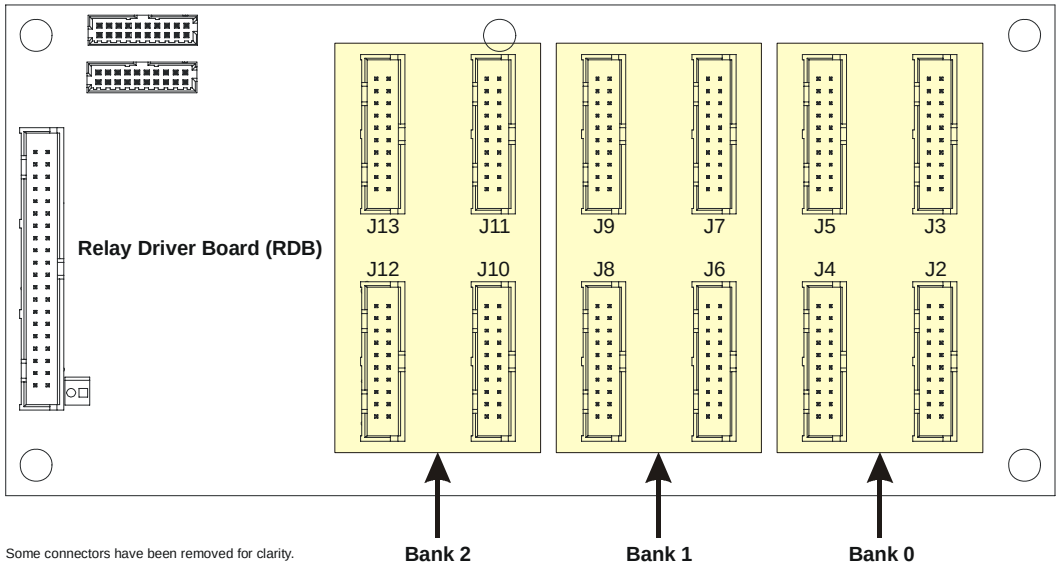



**FIGURE 3-3: RELAY DRIVE CONNECTOR BANKS**

# SECTION 4

# WEB PAGE OPERATION

## INTRODUCTION

The EX7000-OEM offers an embedded web page which provides network configuration control, soft front panel access, time configuration, and the ability to perform firmware upgrades. To open this web page, enter the EX7000's assigned IP address or host name into an Internet browser application, as shown in Figure 4-1.

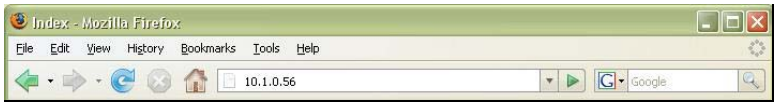



**FIGURE 4-1: IP ADDRESS ENTERED INTO INTERNET BROWSER**

## GENERAL WEB PAGE OPERATION

When initial connection is made to the EX7000, the instrument home page, **Index**, appears (see Figure 4-2. This page displays instrument-specific information including:

- Model
- Manufacturer
- Serial Number
- Description
- LXI Class
- LXI Version
- Hostname
- MAC Address
- IP Address
- Netmask
- Firmware version

This page is accessible from any other instrument page by clicking on the EX7000-OEM web page header.

The EX7000-OEM command menu is displayed on the left-hand side of every internal web page. The entries on the command menu represent three types of pages:

***Status*** This type of page performs no action and accepts no entries. It provides operational status and information only. The **Index** page is an example of a status page.

***Action*** This type of page initiates a command on the instrument, but does not involve parameter entry. The **Reboot** page is an example of an action page.

***Entry*** This type of page displays and accepts changes to the configuration of the instrument. The **Time Configuration** page is an example of an entry page.

Use of the entry-type web pages in the EX7000-OEM are governed by a common set of operational characteristics:

- Pages initially load with the currently-entered selections displayed.
- Each page contains a *Submit* button to accept newly entered changes. Leaving a page before submitting any changes has the effect of canceling the changes, leaving the instrument in its original state.
- Navigation through a parameter screen is done with the Tab key. The Enter key has the same function as clicking the *Submit* button and cannot be used for navigation.

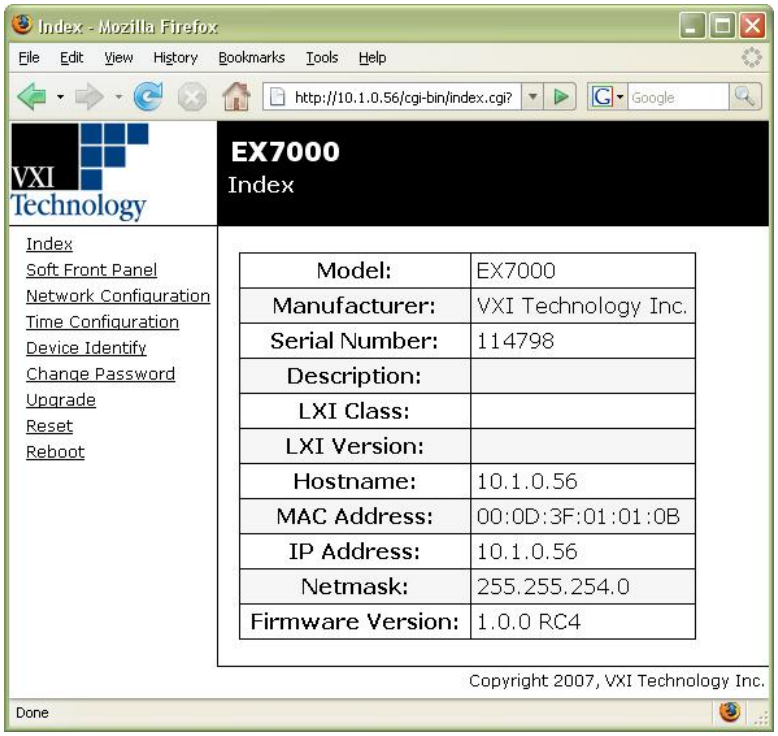



**FIGURE 4-2: EX7000-OEM MAIN WEB PAGE**

### *Password Protection*

Once the IP address has been entered into the address bar of a web browser, the user should define a password for the EX7000-OEM. No password is defined by default. To create a password, click on the **Change Password** link in the command menu, then enter the desired password in both text fields. From this point forward, pages that modify instrument configuration (e.g., Soft Front Panel) require this password to initially login. It is only necessary to enter a password once per session.

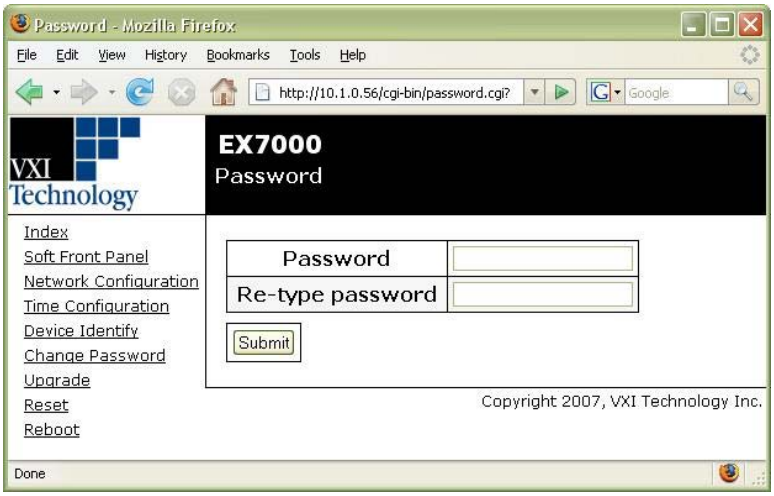



**FIGURE 4-3: EX7000-OEM PASSWORD PAGE**

| | |
|---|---|
| **NOTES** | 1) The instrument password uses lower-case letters.<br>2) This password mechanism provides only the most basic security. Applications requiring additional security should consider using private, dedicated subnets, firewalls, etc. to limit access to the instrument on the network. |

### *VXI Technology Logo*

The VXI Technology logo that appears on the upper left of all EX7000-OEM web pages is a link to the VXI Technology, Inc. corporate website: http://www.vxitech.com.

### *EX7000 Title Block*

The title block ("EX7000" on a black background at the top of the page) of all EX7000-OEM web pages is a link to the Main Web Page.

## SOFT FRONT PANEL

The EX7000-OEM Soft Front Panel page can be seen in Figure 4-4. By accessing this page, the various switch modules, attenuators, and other devices connected to the EX7000-OEM can be viewed, identified, and commanded.

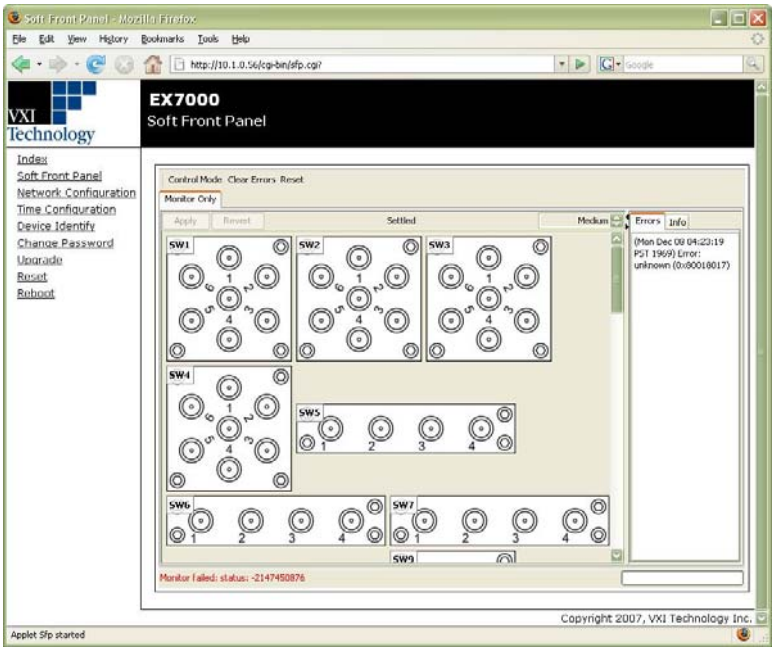



**FIGURE 4-4: EX7000-OEM SOFT FRONT PANEL PAGE**

## NETWORK CONFIGURATION

The EX7000-OEM Network Configuration page can be seen in Figure 4-5. By default, the EX7000-OEM will attempt to locate a DHCP server. If one is found, the IP address assigned by the DHCP server will be assumed, along with subnet masks, gateway, etc. Otherwise, after a timeout of 20 seconds, the unit will attempt to obtain an IP address by using AutoIP (IPv4 Dynamic Link Local Addressing).

| **NOTE** | The EX7000-OEM can be returned to a known, default network configuration by using the LCI (LAN Configuration Initialize) Mechanism. See *Reset Button* for more information. |
|---|---|

AutoIP is a mechanism for finding an unused IP address in the IANA assigned range 169.254.X.Y (169.254/16) where X is in the range 1 - 254 and Y is in the range 0 - 255. The device will first attempt to obtain the specific address 169.254.X.Y, where X and Y are the second-to-last and last octets of the device's MAC address. However, X will be set to 1 if it is 0 in the MAC address, and to 254 if it is 255 in the MAC address for conformance with the AutoIP specifications. If this address is already in use, the unit will attempt to obtain other IP addresses in the 169.254/16 range in a pseudorandom fashion until it finds one that is available.

To illustrate the AutoIP mechanism, Table 4-1 lists the AutoIP default address for some example MAC addresses.

| MAC Address | AutoIP Default Address |
|---|---|
| 00:0D:3F:01:00:01 | 169.254.1.1 |
| 00:0D:3F:01:01:01 | 169.254.1.1 |
| 00:0D:3F:01:A3:28 | 169.254.163.40 |
| 00:0D:3F:01:FE:FE | 169.254.254.254 |
| 00:0D:3F:01:FF:FE | 169.254.254.254 |

**TABLE 4-1: AUTOIP DEFAULT ADDRESS ASSIGNMENT**

If a static IP address assignment is preferred, one can be optionally assigned via the embedded web page interface. This is done by clicking the **Network Configuration** link, disabling DHCP and AutoIP, enabling Static, and then assigning a static IP address, subnet mask, and gateway address, and, optionally, up to three DNS servers (see Figure 4-5).

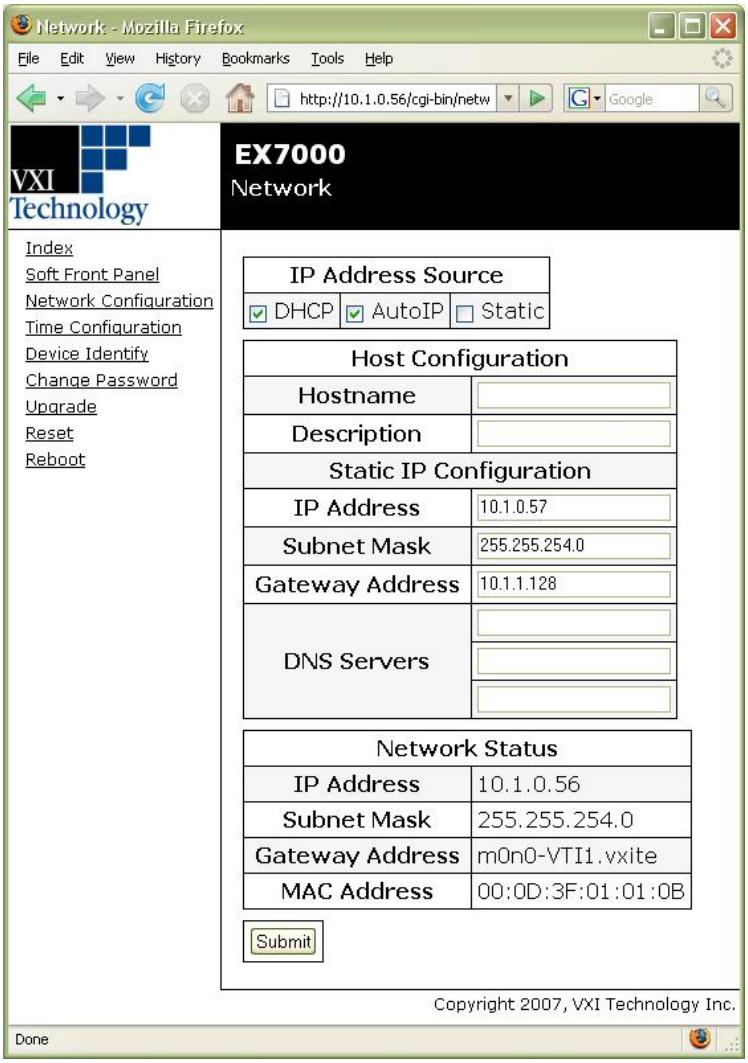



**FIGURE 4-5: EX7000-OEM NETWORK CONFIGURATION**

| **NOTE** | The 169.254/16 subnet is reserved by the IANA for AutoIP usage. It should not be used for either DHCP or static IP configurations. |
|---|---|

However, a much more convenient and recommended way to obtain the benefits of a static IP address is to employ DHCP, but assign the instrument a reserved IP address in your company's DHCP server configuration. This reserved address, linked to the EX7000's MAC address on the DHCP server, would be assigned to the EX7000-OEM at power up initialization without having to manually set it on the EX7000. The DHCP server configuration provides a centralized, controlled database of assigned IP addresses, preventing accidental assignment of the same IP address to multiple instruments. Consult your company's Information Technology department for assistance.

VXI-11 Device Discovery is also supported by the EX7000-OEM. This allows all EX7000-OEMs on a local network to be found without knowledge of their MAC address or IP address with the use of a broadcast message. Additionally, EX7000-OEMs provides MDSN (multicast domain name system) support and may be discovered by software such as Bonjour®.

## TIME CONFIGURATION

This entry page is used to change the time configuration of the EX7000OEM. By default, the instrument has no notion of "wall-clock" or calendar time. The instrument has no battery-backed clock or any other mechanism to retain time between reboots and power-cycles. By default, the instrument's time and date at power-up are midnight, January 1, 1970 (the beginning of the "epoch"). The time and date can be manually specified on the Time Configuration page (Figure 4-6). Manual configuration will be necessary if the network environment is such that the instrument cannot reach the Internet. Manual time entry is not affected by the **Time Zone** control and does not require an instrument reboot to be activated. However, manually-specified time is volatile, and, therefore, must be reentered upon an instrument reboot or power cycle. It is not, however, affected by the **Reset** page.

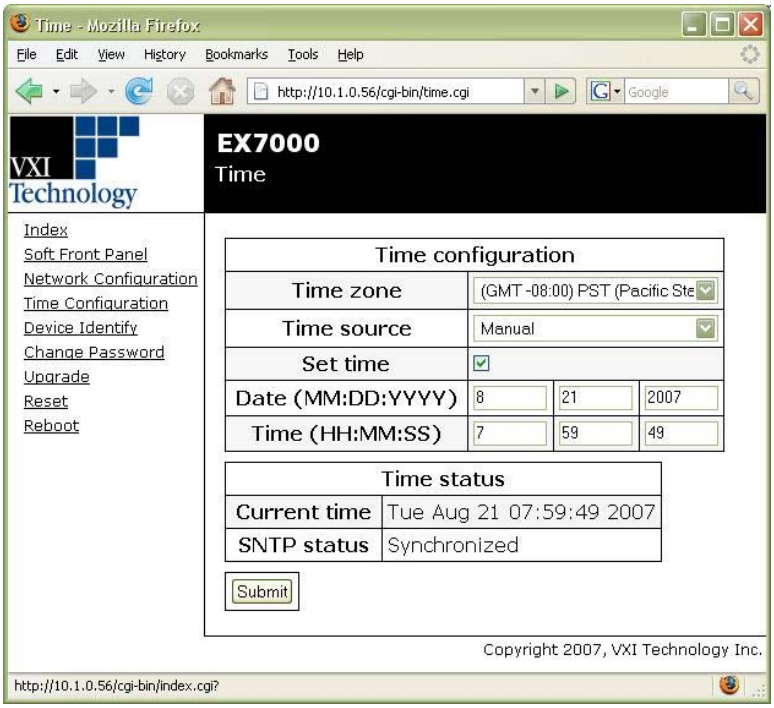



**FIGURE 4-6: EX7000-OEM TIME CONFIGURATION WEB PAGE – MANUAL**

Optionally, the EX7000-OEM supports SNTP (Simple Network Time Protocol), allowing it to receive its time from an SNTP server. The **Time Zone** control provides a pull-down selection in which the user's specific time zone is selected. SNTP or PTP (Peer-To-Peer Time Synchronization or IEEE 1588) servers are specified in the Server configuration panel, by IP Address or hostname. An instrument reboot is then required to activate the new selection.

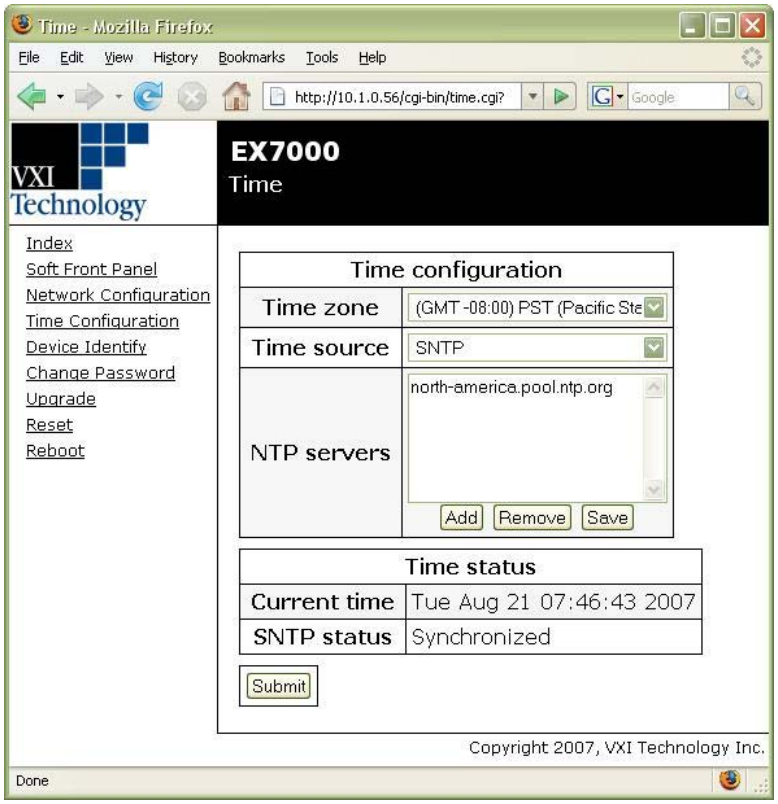



**FIGURE 4-7: TIME CONFIGURATION WEB PAGE – SNTP**

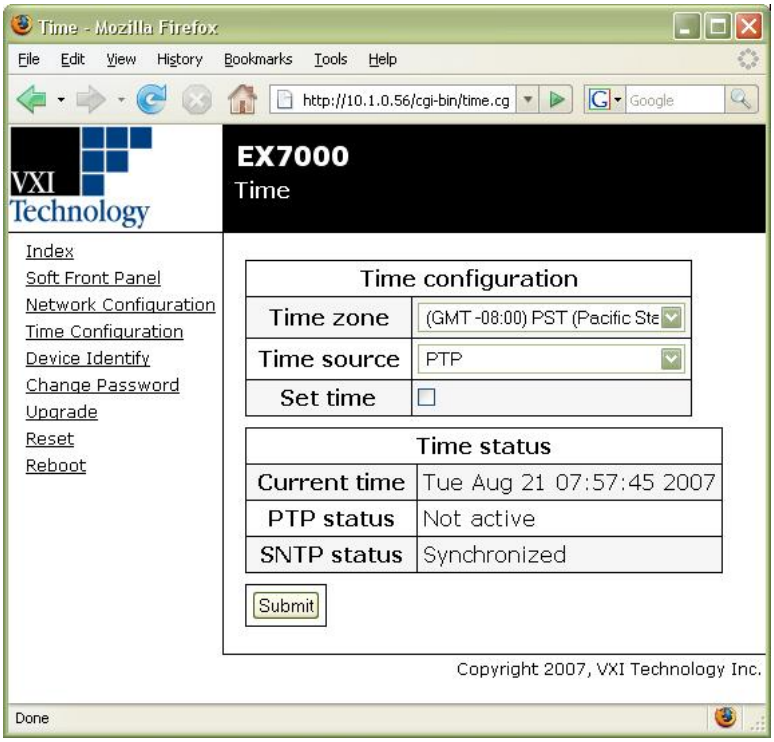



**FIGURE 4-8: TIME CONFIGURATION WEB PAGE – PTP**

| **NOTE** | Specifying SNTP or NTP servers by hostname requires that the instrument be configured for DNS, either by DHCP or Static IP. |
|---|---|

## DEVICE IDENTIFY

This action page is used to identify the EX7000-OEM that is being commanded in the current session. When the "Turn on" button is pressed, the LAN LED located on the rear panel of the EX7000-OEM will blink. When the "Turn off" button is pressed, the LAN LED returns to its normal operation. For more information on EX7000-OEM LEDs, see the *LED Connectors* section.

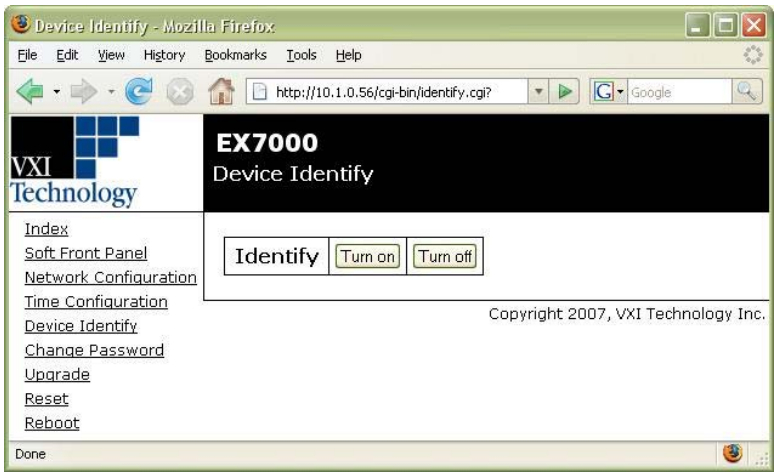



**FIGURE 4-9: DEVICE IDENTIFY WEB PAGE**

## UPGRADE

This action page is used to upgrade the embedded firmware of the EX7000-OEM. Prior to initiating the firmware upgrade process, a new, uncompressed firmware image must be obtained from VXI Technology and be accessible from the computer that is connected to the EX7000-OEM. Unless specifically noted by VXI Technology, firmware upgrades do not alter the calibration or non-volatile configuration settings (network configuration, time configuration) of the EX7000-OEM.

| **NOTE** | Do not power cycle the EX7000-OEM during the firmware upgrade process. If power is lost during the upgrade, the instrument may be put into an inoperable state, requiring return to the factory. An uninterruptible power supply may be used to avoid this risk. |
|---|---|

**FIGURE 4-10: UPGRADE WEB PAGE**

Perform the following steps to conduct a firmware upgrade:

1) Perform a **Reboot** or a power cycle.
2) Connect to the EX7000-OEM via the embedded web page.
3) Click on the **Upgrade** link.
4) Click on the *Browse* button and select the firmware image file to be uploaded to the instrument.
5) Click the *Submit* button to initiate the upgrade process.

The upgrade process takes approximately 5 minutes to complete and will be followed by a prompt to reboot the instrument. Once the reboot is complete, reconnect and confirm on the **Index** page that the firmware revision level has been properly updated.

## RESET

This action page is used to return the EX7000-OEM to a known communication state. Pressing the Reset button will cause the EX7000-OEM to terminate all active sessions, leaving only the current session viable.

## REBOOT

This action page is used to perform a complete instrument reboot, equivalent to that which occurs when the instrument is power cycled. It is most commonly used to accept changes that are made to the network configuration or time configuration settings. In addition, it is suggested that a reboot be performed before conducting a firmware upgrade.

# SECTION 5

# THEORY OF OPERATION

## INTRODUCTION

This section expands on the description of the EX7000-OEMs features and explains how to best use them. A functional block diagram is provided below.

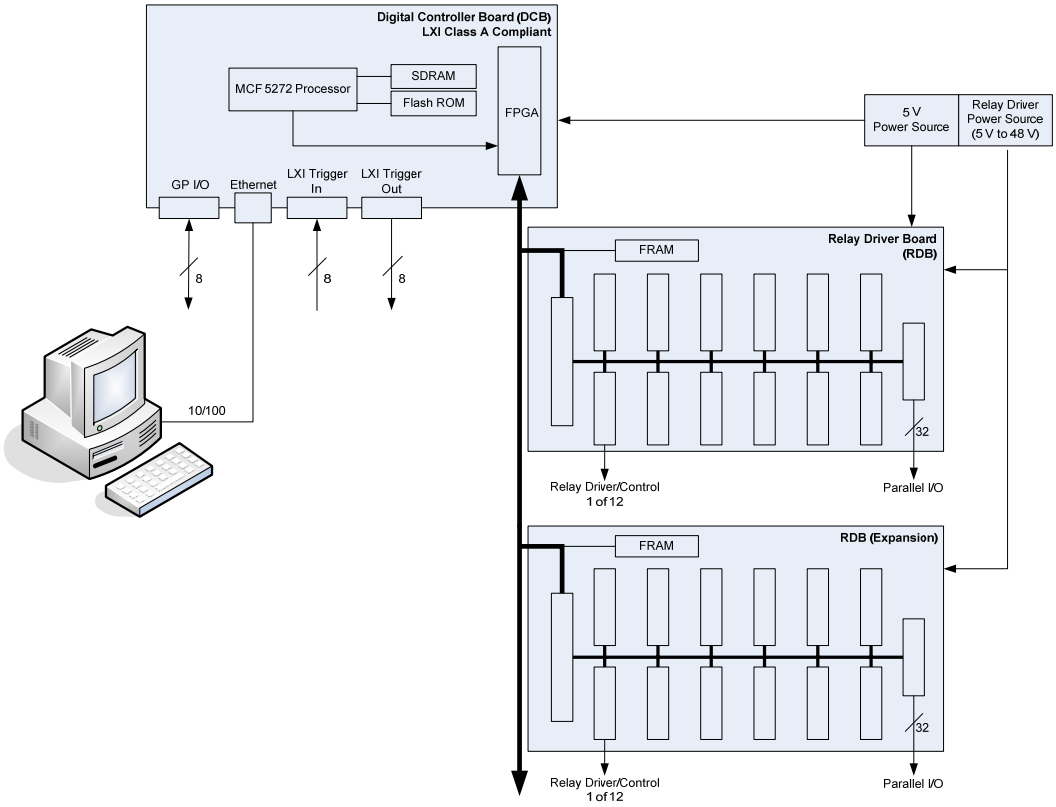



**FIGURE 5-1: FUNCTIONAL BLOCK DIAGRAM**

## SYSTEM OVERVIEW

Using the drivers provided with the EX7000-OEM, commands are issued from the host PC to the Digital Controller Board (DCB). The DCB, in turn, controls the operation of the Relay Driver Boards (RDBs). Up to eight RDBs can be controlled by one DCB, making the EX7000-OEM capable of providing up to 576 relay control driver, 96 high-current drivers, and 256 parallel I/O ports. This is illustrated in Figure 5-1.When multiple RDBs exist in an EX7000-OEM system, a rotary switch on the RDB is used to set a unique address for each RDB.

RDBs can either be commanded one board at a time or several RDBs may be commanded simultaneously. The RDB has 72 relay control drive lines capable of sinking 200 mA and twelve high-current reset lines capable of sinking 800 mA. They are divided into three banks, each can be powered separately. Each bank consists of four 20-pin connectors. Each connectors consists of:

- six high-current drive lines
- six indicator/status bits
- one reset line
- four relay ID bits
- one relay power input
- one 5 V input
- one ground

| **NOTE** | All devices connected to a particular bank (i.e. group of four connectors) must be of the same type: continuous or latching. Mixing of different type may result in erratic behavior and damage to overall system. |
|---|---|

## RELAY ACCESS & CONTROL

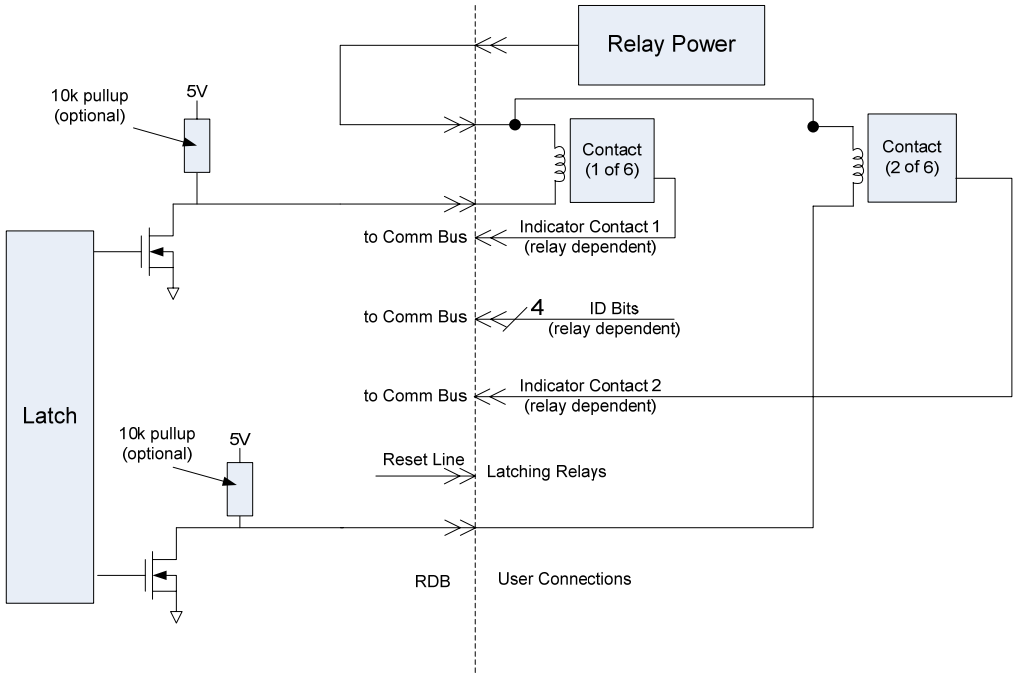



**FIGURE 5-2: RELAY DRIVER BLOCK DIAGRAM**

The following connections should be made:

1) The Relay Power line (PWR_BANKx) to the positive sides of all relay coils.
2) The Relay Drive line (RELAY_DRIVEx) to the negative sides of the coils.

When asserted, the relay drive lines will sink the necessary current through the coils, effectively switching the Relay. The user can program the relay settling time for each RDB.

The relay control can be operated in 2 modes: Pulse and Continuous

***Continuous Mode***

Connecting non-latching devices to any bank of the Relay Driver Board will dictate that bank must be operating in continuous mode. Commanded by software, the latch signal driving the FET will change state to activate/deactivate FETs and continuously stay in that state until the next command. All Relay Control Drive bits within a bank will change state at the same time. Continuous mode requires a power supply capable of sustaining the high current requirement. The user must allow an appropriate amount of time after the Relay Control Drive bit changes state for the relay to settle. This is typically between 10 ms to 30 ms.

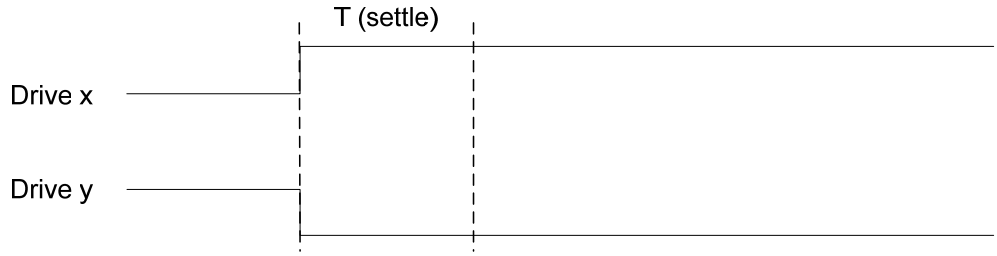



**FIGURE 5-3: CONTINUOUS OPERATION MODE**

***Pulse Mode***

Connecting latching devices to any bank of the Relay Driver Board will dictate that bank must be operating in pulse mode. Commanded by software, the latch signal driving the FET will change state to activate FETs and then change state back when the settling time is reached. All Relay Control Drive bits within a bank will change state at the same time. Certain latching devices will require a reset signal to move all latches to a known state prior to a new state is applied. The Reset signal will be a pulse with the same duration as the Relay Control Drive. The pulse width should exceed the settling time specification for the relays being used. This value will be used as both pulse width and settling time.

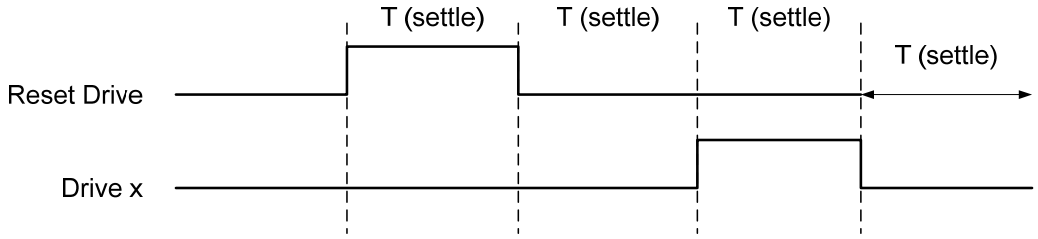



**FIGURE 5-4: PULSE OPERATION MODE**

| **NOTE** | There is no current monitoring capability on the EX7000. It is the user's responsibility to estimate the total current requirement and provide sufficient power supply current. |
|---|---|

The user can mix and match non-latching and latching devices among the banks. For instance, bank 1 and 3 can be all latching, bank 2 can be non-latching. The Relay Driver Board, if set up properly, will be able to control all of the devices.

In case of multiple Relay Driver Boards, all devices in different boards can be controlled in parallel as long as the current requirement is met. The user does not have to wait for one Relay Driver Board to finish its operation before moving to the next. On the contrary, the user can also control one Relay Driver Board at time. The settling time in case of multiple Relay Driver Board will be the longest between the boards, multiply with the aggregate number of banks connecting to latching devices.

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